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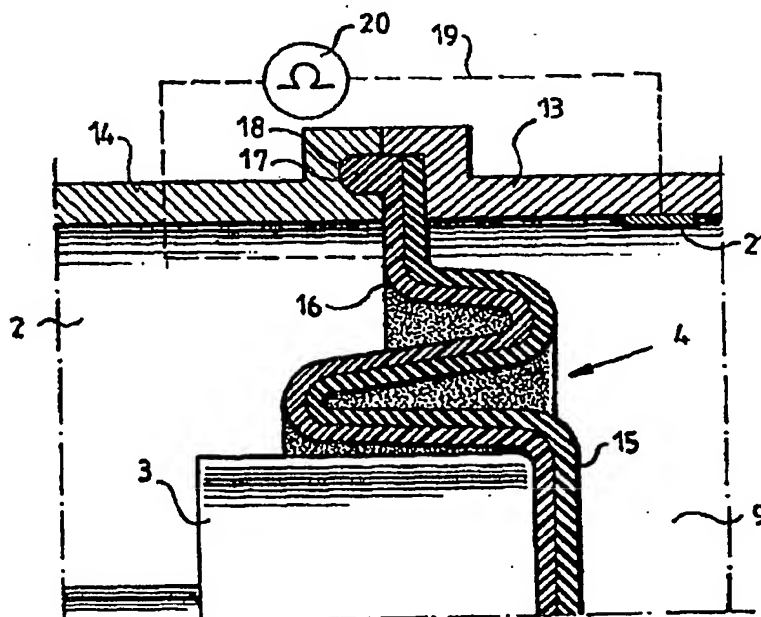
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G01M 3/16, 3/18, F04B 43/00		A1	(11) International Publication Number: WO 95/27194
			(43) International Publication Date: 12 October 1995 (12.10.95)
(21) International Application Number: PCT/EP95/00705		(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).	
(22) International Filing Date: 27 February 1995 (27.02.95)		Published With international search report.	
(30) Priority Data: MI94A000615 31 March 1994 (31.03.94) IT			
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(54) Title: A DEVICE FOR LEAKAGE DETECTION

(57) Abstract

A device for leakage detection in pumps or other assemblies for handling electrically conductive, pumpable products, e.g. previously sterilized liquid foods, has a diaphragm which includes, on the one hand, a liquid-tight layer (15) which is located in contact with the product, and, on the other hand, an electrically conductive material layer (16) discrete from the product. The conductive layer (16) is, via a conductor (19) with an indicator (20), electrically connected to the product, and when cracks occur in the diaphragm so that the product comes into contact with the electrically conductive layer, a closed current circuit will be made, which immediately indicates the leakage and makes it possible to avoid the leakage resulting in a contaminated and destroyed product.



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## A DEVICE FOR LEAKAGE DETECTION

### TECHNICAL FIELD

5 The present invention relates to a device for detecting flaws in diaphragms which are in contact with electrically conductive, pumpable products.

### BACKGROUND ART

10 The handling of foods or other sensitive products requires stringent hygiene. This is particularly the case when the products involved have been treated beforehand (eg. by means of heat sterilization) so as to prevent the growth of micro-organisms and impart to the product a long shelf life. As a result, the transport, pumping and filling of such previously sterilized products take place in completely closed systems which are manufactured from some suitable, bacteria-proof material such as stainless steel. With the aid of conduit systems and pumps, the products (which commonly comprise liquids of varying viscosities or pulps containing larger or smaller quantities of liquid) are transported from the sterilization apparatus or interjacent storage vessel (holding tanks) to those packaging containers which are employed for selling the product to individual consumers. In addition to the conduit system proper, pumps are also required for this purpose, and possibly also pressure vessels and pressure equalization apparatuses, for example of the type described in GB Patent 1.550.080. In particular in pumps, and in certain types of pressure equalization apparatuses, narrow gaps occur (for example between piston and cylinder walls in a piston pump) in which product residues may accumulate and are removed only with difficulty in connection with cleaning of the system. This problem is normally avoided in that the pump or the relevant assembly is provided with a flexible diaphragm which is connected in a tightly sealed manner with the walls of the pump housing. The above-outlined problems are hereby solved, but instead there then occurs the risk that flaws in the diaphragm, such as crack formation, pores or the like, allow the penetration of product and cause difficulties in guaranteeing that the desired aseptic level of dependability is maintained. One prior art method of obviating this problem is to provide, on the rear side of the diaphragm, a vacuum chamber in which penetrating product may be detected. However, such detection takes place

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at a relatively late stage, since a certain quantity of product must have had time to pass the diaphragm and enter into the vacuum chamber before it becomes possible to detect the leakage. An arrangement of this type is disclosed in European Patent 410.125. For the above-outlined reasons, there is a general need in the art to devise an arrangement which makes it possible, both reliably and at a very early stage, to detect the occurrence of flaws such as cracks or pores in diaphragms of the type which are employed in direct contact with pumpable products, for example previously sterilized contents such as milk, juice or the like.

### OBJECTS OF THE INVENTION

One object of the present invention is to realize a device which makes it possible, in a simple and reliable manner, immediately to indicate the occurrence of a leakage in a diaphragm which is located in contact with an electrically conductive product, eg. a liquid or a pulp containing liquid.

A further object of the present invention is to realize a device for leakage detection, the device being of simple and dependable design and construction and being capable of being manufactured and put into use at low cost.

Yet a further object of the present invention is to realize a device for detecting flaws in diaphragms, the device not appreciably complicating the design of the assembly in which the detection operation is to take place, for example a pump.

Still a further object of the present invention is to realize a leakage detector which, with absolute reliability, detects leakage at such an early stage that there is no time for any contamination of the pumped, sterile product to take place.

### SOLUTION

The above and other objects have been attained according to the present invention in that a device for detecting flaws in diaphragms which are in contact with electrically conductive, pumpable products has been given the characterizing feature that the diaphragm is provided with a liquid-tight layer which is located between the product and an electrically conductive material layer which, via a conductor provided with an indicator, is in electric connection with the product.

Preferred embodiments of the present invention have further been given the characterizing features as set forth in the appended subclaims.

### ADVANTAGES

5 By utilizing, according to the present invention, an electrically conductive layer integrated in a diaphragm and a conductor uniting this with the product, an integrated system will be created which simply and efficiently gives an electric indication as soon as a leakage occurs in the liquid-tight diaphragm layer. The device is extremely simple and replaces  
10 those complicated arrangements employing vacuum sources, vacuum chambers etc., which have previously been employed to give a similar - albeit less reliable - indication of leakage in diaphragms in aseptic pumps.

### BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

15 One preferred embodiment of the device according to the present invention will now be described in greater detail hereinbelow, with particular reference to the accompanying, schematic Drawing which merely shows those details indispensable to an understanding of the invention. In the accompanying Drawing:

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Fig. 1 is a sectional view of an assembly with a device according to the present invention; and

Fig. 2 shows, on a larger scale, a part of the device of Fig. 1, seen in section.

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### DESCRIPTION OF PREFERRED EMBODIMENT

The device according to the invention is illustrated and described as it may be designed when employed in an assembly for pumping or pressure equalization in a conduit for pumpable products of the type which  
30 places stringent demands on hygiene and bacteria-tightness, eg. in the pumping of previously sterilized food products at packaging machines. The device according to the present invention may, however, also be employed in other types of assemblies such as tanks or the like fitted with diaphragms.

Referring to the Drawing, the assembly 1 illustrated in Fig. 1  
35 comprises a cylinder 2 with a piston 3 whose end surface abuts against a diaphragm 4 which is connected in liquid and bacteria-tight fashion to the

cylinder 2 in an annular diaphragm mount 5 extending about the cylinder. The piston 3 is connected via a piston rod 6 to a cam follower 7 in the form of a freely rotary roller which abuts against a cam 8 which is driven by a prime mover (not shown) eg. an electric motor. In the end of the cylinder 2 facing away from the cam 8, there is disposed a product chamber 9 which is defined partly by the previously mentioned diaphragm 4 and partly by the end wall 10 of the cylinder 2. The product chamber 9 displays an inlet 11 and an outlet 12 which, when the assembly serves as a pump, are provided with valves (not shown) of known type which serve to direct the flow one-way through the product chamber 9. The cylinder 2 includes a front cylinder wall 13 and a rear cylinder wall 14 which meet at the diaphragm mount 5 which includes an appropriately designed groove in the end surfaces of the cylinder walls 13 and 14 facing one another. The front and rear cylinder walls 13 and 14, respectively, are held together by means of bolts (not shown) or other suitable fixing devices.

The diaphragm 4 includes a liquid-tight layer 15 and an electrically conductive layer 16 which are brought together and united with one another so as to form one unit, the diaphragm 4. Both the liquid-tight layer 15 and the electrically conductive layer 16 are manufactured from a flexible rubber or plastics material, for example silicon of the type which is approved for use together with foods. The electrically conductive diaphragm layer 16 may consist of conductive silicon of known type, or a rubber or plastics material with embedded conductors in the form of wires or fibres of electrically conductive material. The electrically conductive layer is, at its outer periphery, provided with a bead 17 which, together with a corresponding groove 18 in the end surface of the rear cylinder wall 14, guides the diaphragm when the two cylinder walls 13 and 14 are joined together. If the cylinder walls are manufactured from an electrically conductive material, the conductive layer 16 of the diaphragm must be insulated from direct contact with the front cylinder wall 13, as will be explained in greater detail hereinbelow. As is apparent from the Figures, the diaphragm 4 is preferably serpentine so as to reduce the stresses in connection with the movements of the piston 3, but it is naturally also conceivable, for example in the event of relatively slight piston movements, to employ a more or less planar diaphragm.

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the diaphragm 4 (and as soon as the crack reaches such depth that the product, via the crack, comes into contact with the electrically conductive layer 16), the current circuit made up via the layer 16, the conductor 19 and the product 9 will be closed so that the ohmmeter 20 or some other, preferred indicator, will signal the presence of current in the conductor 19 and emit the desired optic or acoustic signal. This will take effect already

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It will be apparent from Fig. 2 how the electrically conductive layer 16 of the diaphragm 4 is, by means of a conductor 19 via an indicator 20 (eg. an electric resistance meter or ohmmeter), connected to the cylinder wall 13 or, in those cases when the cylinder wall 13 is not manufactured from an electrically conductive material, to a contact plate 21 which is located at the inside of the cylinder wall 13, i.e. in direct contact with the product located in the product chamber 9. Instead of the described conductor 19 provided with an ohmmeter 20, a conductor with an electric current source and some suitable signal arrangement may be employed, this being adjusted so as to emit a signal when current flows through the conductor 19.

When an assembly 1 of the type illustrated in the Figures is utilized for, for example, pumping an electrically conductive food product, for example in the form of a liquid such as milk or the like, or alternatively a pulp which contains liquid, for instance viscous, slurry-like products, the device according to the invention may be employed for detecting flaws in the diaphragm 4, for example leakages which occur during operation and which may entail rupture in the aseptically tight wall which surrounds the product when this is fed via a conduit system from, for instance, a sterilizer to a packaging or filling machine. As also the cleaning agents that are used for the cleaning of the system are conductive fluids or products, the advice will indicate leakages also during the cleaning phase. During pumping, the cam 8 is rotated with the aid of an electric motor (not shown), the cam driving the piston rod 6 via the follower 7 in a reciprocating movement which, via the piston 3, is transmitted to the diaphragm 4 so that the wall formed in the product chamber 9 by the diaphragm 4 reciprocates, in which event the volume in the product chamber 9 periodically varies. With the aid of the above-mentioned conventional valves (not shown) in the inlet 11 and outlet 12, it will be ensured that the volume variations in the product chamber 9 result in a one-way product flow as indicated by means of arrows in Fig. 1. The pumped product is, in such instance, in contact with the contact plate 21, but as long as the liquid-tight layer 15 of the diaphragm 4 does not display any flaws in the form of a crack or pores, no contact will be established between the product and the electrically conductive layer 16 of the diaphragm 4, since this layer is, with the aid of the liquid-tight layer 15 and the insulated diaphragm mount 5, electrically completely discrete from the product. However, if a crack were to occur in the liquid-tight layer 15 of

**WHAT IS CLAIMED IS:**

- 5 1. A device for detecting flaws in diaphragms (4) which are in contact with electrically conductive, pumpable products, **characterized in that** the diaphragm (4) has a liquid-tight layer (15) which is located between the product and an electrically conductive material layer (16) which, via a conductor (19) provided with an indicator (20), is in electric connection with the product.
- 10 2. The device as claimed in Claim 1, **characterized in that** the diaphragm (4) includes layers (16, 15) of, on the one hand, electrically conductive, flexible material, and, on the other hand, non-conductive liquid-tight and flexible material.
- 15 3. The device as claimed in Claim 2, **characterized in that** the diaphragm (4) comprises united layers (15, 16) of electrically conductive and liquid-tight silicon, respectively.
- 20 4. The device as claimed in Claim 1, 2 or 3, **characterized in that** the diaphragm (4) constitutes one wall in a product chamber (9).
5. The device as claimed in Claim 1, **characterized in that** the indicator (20) is an ohmmeter.

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Fig. 1

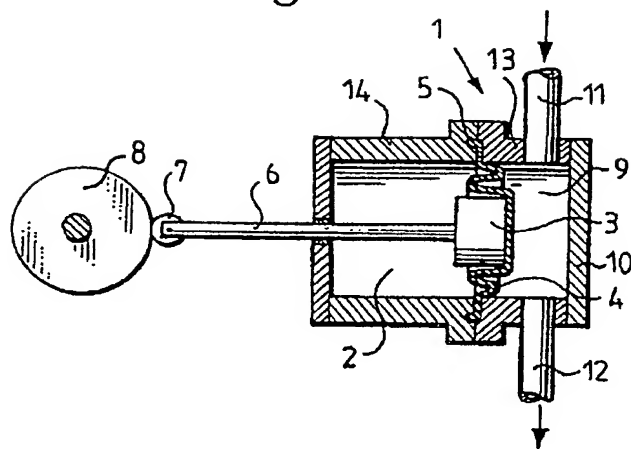
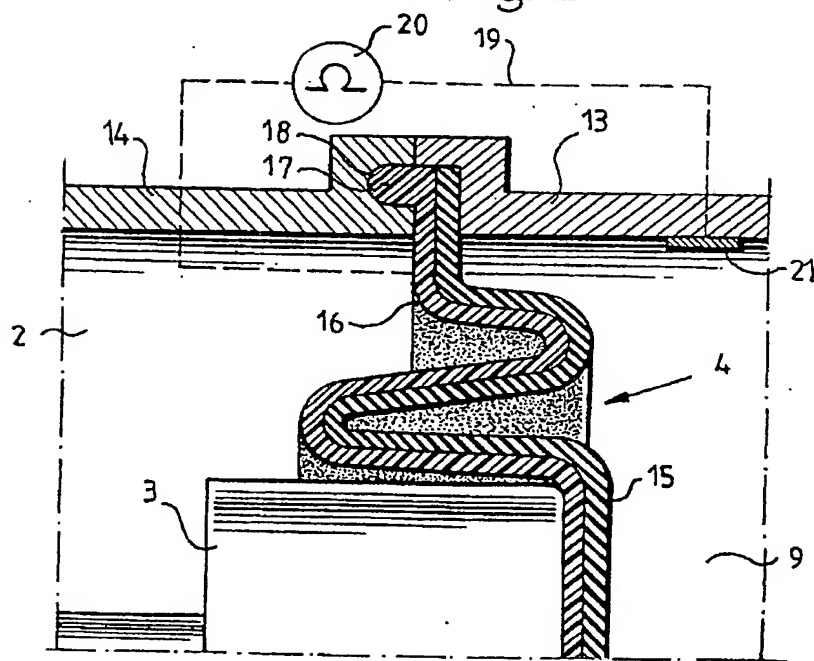


Fig. 2





# INTERNATIONAL SEARCH REPORT

Internati Application No  
PCT/EP 95/00705

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 G01M3/16 G01M3/18 F04B43/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 G01M F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,B,29 43 509 (MARTIN MERKEL KG) 29 January 1981	1,2,4
A	see column 5, line 51 - column 6, line 10; figure 2	5
A	----- PATENT ABSTRACTS OF JAPAN vol. 11, no. 289 (M-625) 18 September 1987 & JP,A,62 082 286 (NIKKISO CO. LTD.) 15 April 1987 see abstract	1,2
A	----- US,A,4 569 634 (MANTELL) 11 February 1986 see the whole document -----	1,2,4,5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

9 June 1995

Date of mailing of the international search report

28.06.95

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## INTERNATIONAL SEARCH REPORT

Internati Application No  
PCT/EP 95/00705

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-B-2943509	29-01-81	NONE	
US-A-4569634	11-02-86	US-A- 4787825	29-11-88
		US-A- 4934902	19-06-90
		US-A- 4740139	26-04-88

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